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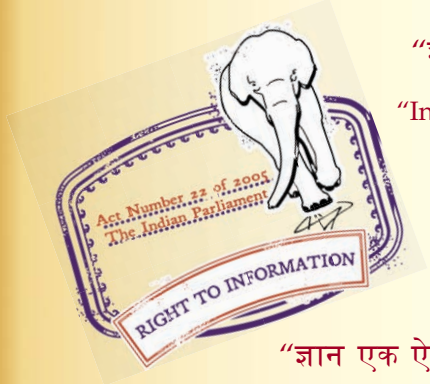

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IS : 5121 - 1969
(Reaffirmed 2005)

Indian Standard

SAFETY CODE FOR PILING AND OTHER DEEP FOUNDATIONS

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Indian Standard

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Indian Standard

SAFETY CODE FOR PILING AND OTHER DEEP FOUNDATIONS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 May 1969, after the draft finalized by the Safety in Construction Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Pile driving and well sinking are specialized jobs involving a lot of hazards which sometimes lead to accidents. It is necessary that certain safety rules are laid down for every phase of work involved and that these are meticulously followed by each member of the crew working on the jobs, not only for his own safety but also for the safety of his fellow workers and onlookers. This standard has, therefore, been formulated to lay down safety requirements for pile driving and for preparing deep foundations including well sinking.

0.3 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country.

0.4 This standard is one of a series of Indian Standards on safety in construction.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard lays down the safety requirements for piling and other deep foundations as stated below:

a) Safety measures while working with a piling rig, and

b) Safety measures while preparing other deep foundations.

*Rules for rounding off numerical values (*revised*).

2. GENERAL

2.1 Safety Programme — All operations shall be carried out under the immediate charge of a properly qualified and competent foreman. The foreman shall also be responsible for the safety arrangements of the work.

2.2 Fencing shall be provided, wherever necessary, around the working area or watchmen provided to prevent onlookers from tresspassing into the construction sites. For work during the night lighting of at least 100 lux intensity shall be provided at the work site.

2.3 The working area shall be investigated to ascertain the presence of any buried obstruction and actual position of all service lines passing through the work site shall be known before the work commences. Particular attention shall be given in case live electrical cables pass underground, which may interfere within the depth of foundation.

2.4 The safety provisions shall be brought to the notice of all concerned and matters needing special attention shall be displayed at a prominent place at the work spot.

2.5 All necessary safety equipment like safety belts and safety helmets and safety shoes, as considered suitable, shall be kept available for the use of persons employed on the site and maintained in condition suitable for immediate use.

2.6 A first-aid kit shall be maintained at the site near the place of work, to comply with the requirements and provisions for the work.

2.7 Those engaged in mixing and stacking of cement bags or any other material injurious to human body shall be provided with protective wear suitable for the purpose. Welders engaged in the work of welding shall use eye sight shields.

2.8 Every crane driver or hoisting appliance operator shall be competent to the satisfaction of the engineer-in-charge and no person under the age of 21 years should be in-charge of any hoisting machine including any scaffolding winch, or give signals to operator.

3. PILING RIG

3.1 There are numerous types of piling rigs in piling work, depending on the need for the site conditions. While utilizing specialized rigs the instructions issued by the suppliers shall be kept in view.

3.1.1 Pile drivers shall not be erected in dangerous proximity to electric conductors.

3.1.2 If two pile drivers are erected at one place these shall be separated by a distance at least equal to the longest leg in either rig.

3.2 The frame of any rig shall be structurally safe for all anticipated dead, live or wind loads. Whenever there is any doubt about the structural strength, suitable test shall be carried out by the foreman and the results of the test recorded. No pile-driving equipment shall be taken into use until it has been inspected and found to be safe.

3.3 Pile drivers shall be firmly supported on heavy timber sills, concrete beds or other secure foundation. If necessary to prevent danger, pile drivers shall be adequately guyed.

3.3.1 When the rig is not in use, extra precautionary measures for stability, such as securing them with minimum four guys, shall be adopted to prevent any accidents due to wind, storm, gales, and earthquake.

3.4 Access to working platforms and the top pulley shall be provided by ladders. Working platforms shall be protected against the weather.

3.4.1 In tall driven piling rigs or rigs of similar nature where a ladder is necessary for regular use, the ladder shall be securely fastened and extended for the full height of the rig. The ladder shall also be maintained in good condition at all times.

3.5 Exposed gears, fly wheels, etc, shall be fully enclosed. Boilers, hoisting drums and brakes shall be kept in good condition and sheltered from weather, wherever possible.

3.6 Pile driving equipment in use shall be inspected by a competent engineer at regular intervals not exceeding three months. Also a register shall be maintained at the site of work for recording the results of such inspections. Pile lines and pulley blocks shall be inspected by the foreman before the beginning of each shift. for any excess wear or any other defect.

3.6.1 Defective parts of pile drivers, such as sheaves, mechanism slings and hose shall be repaired by only competent person and duly inspected by foreman-in-charge of the rig and the results recorded in the register.

3.6.2 No steam or air equipment shall be repaired while it is in operation or under pressure.

3.6.3 Hoisting ropes on pile drivers shall be made of galvanized steel.

3.7 All bolts and nuts which are likely to be loosened due to vibration during pile driving shall be checked regularly and tightened.

3.8 Steam and air lines shall be controlled by easily accessible shut-off valves. These lines shall consist of armoured hose or its equivalent. The hose of steam and air hammers shall be securely lashed to the hammer so as to prevent it from whipping if a connection breaks. Couplings of sections of hose shall be additionally secured by ropes or chains.

3.9 When not in use the hammer shall be in dropped position and shall be held in place by a cleat, timber or any other suitable means.

3.10 For every hoisting machine and for every chain ring hook, shackle, swivel and pulley block used in hoisting or as means of suspension, the safe working loads shall be ascertained. In case of doubt actual testing shall be carried out and the working load shall be taken as half of the tested load. Every hoisting machine, and all gears referred to above shall be plainly marked with the safe working load. In case of a hoisting machine having a variable safe working load, each safe working load together with the conditions under which it is applicable shall be clearly indicated. No part of any machine or any gear shall be loaded beyond the safe working load except for the purpose of testing.

3.11 Motor gearing, transmission, electrical wiring and other dangerous parts of hoisting appliances should be provided with efficient safe guards. Hoisting appliances shall be provided with such means as will reduce, to the minimum, the risk of accidental descent of the load and adequate precautions shall be taken to reduce to the minimum, the risk of any part of suspended load becoming accidentally displaced. When workers are employed on electrical installations which are already energised, insulating mats and wearing apparel, such as gloves, etc, as may be necessary, shall be provided. Sheaves on pile drivers shall be guarded so that workers may not be drawn into them.

3.11.1 When loads have to be inclined:

a) they shall be adequately counter-balanced; and

b) the tilting device shall be secured against slipping.

3.12 Adequate precautions shall be taken to prevent a pile driver from overturning if a wheel breaks.

3.13 Adequate precautions shall be taken by providing stirrups or by other effective means, to prevent the rope from coming out of the top pulley or wheel.

3.14 Adequate precautions shall be taken to prevent the hammer from missing the pile.

3.15 If necessary to prevent danger, long piles and heavy sheet piling should be secured against falling.

3.16 Wherever steam boilers are used, the safety regulations of boiler shall be strictly followed and safety valves shall be adjusted to 0·7 kg/cm^2 in excess of working pressure accurately.

3.17 Where electricity is used as power for piling rig, only armoured cable conforming to the relevant Indian Standard shall be used and the cable shall be thoroughly waterproofed.

4. OPERATION OF EQUIPMENT

4.1 Workers employed in the vicinity of pile drivers shall wear helmets conforming to IS:2925-1964*.

4.2 Piles shall be prepared at a distance at least equal to twice the length of the longest pile from the pile driver.

4.3 Piles being hoisted in the rig should be so slung that they do not have to be swung round, and may not inadvertently, swing or whip round. A hand rope shall be fastened to a pile that is being hoisted to control its movement. While a pile is being guided into position in the leads, workers shall not put their hands or arms between the pile and the inside guide or on top of the pile, but shall use a rope for guiding.

4.4 While a pile is being hoisted all workers not actually engaged in the operation shall keep at a distance which ensures safety.

4.5 Before a wood pile is hoisted into position it shall be provided with an iron ring or cap over the driving end to prevent brooming.

4.6 When creosoted wood piles are being driven, adequate precautions shall be taken, such as the provision of personal protective equipment and barrier creams to prevent workers receiving eye or skin injuries from splashes of creosote.

4.7 When piles are driven at an inclination to the vertical, if necessary to prevent danger, these should rest in a guide.

4.8 No steam or air line shall be blown down until all workers are at a safe distance.

5. FLOATING PILE DRIVERS

5.1 When pile drivers are working over water a suitable boat shall be kept readily available at all times. All members of floating pile-driver crews shall be trained to handle boats and shall also know swimming.

5.2 Floating pile drivers shall be provided with a whistle, siren, horn or other effective signalling equipment.

5.3 Floating pile drivers shall be provided with adequate fire fighting equipment.

5.4 The weight of machinery on a floating pile driver shall be so distributed that the deck of the installation is horizontal. Further, it shall be ensured that the floating craft is stable and safe under all working conditions.

*Specification for industrial safety helmets.

5.5 Steel pile-driver hulls shall be divided into watertight compartments, and the watertight compartments should be provided with siphons for the removal of water seepage.

5.6 Deck hatches shall have firmly fastened covers that fit flush with the deck. Open hatches shall be adequately fenced or guarded.

5.7 Fuel tanks below deck shall be vented to the outside and vents shall be provided with flame arrestors. For each fuel tank below deck there shall be an emergency shut-off valve on deck.

5.8 Lighting fixtures below deck shall be explosion proof and flame proof.

5.9 Sufficient sheaves shall be provided on deck to enable the pile driver to be safely manoeuvred in any direction and safely secured in position.

5.10 The operator's cabin shall afford an unrestricted view of the operations.

6. SHEET PILING

6.1 If necessary to prevent danger from wind or other sources, a hand rope shall be used to control the movement of steel sheet sections that are being transported.

6.2 Workers who have to sit on a steel sheet section to interlock sheets shall be provided with stirrups or other devices to afford them a safe seat. Workers shall not stand or sit on sheet piling while it is being released from the slings, lowered or moved into position.

6.3 Workers handling sheets should wear gloves.

6.4 If necessary to prevent danger from displacement by the current, steel sheet sections shall be braced until they are firmly in position. If necessary to prevent danger from undercutting of the cofferdam by the current a substantial berm shall be installed upstream.

6.5 While it is being weighted with stones, sheet piling should be securely moored.

6.6 Adequate pumping facilities shall be available at cofferdams to keep them clear of water. Also adequate means of escape, such as ladders and boats shall be provided at cofferdams for the protection of workers in case of flooding.

6.7 Adequate supplies of life-saving equipment shall be provided for workers employed on cofferdams.

6.8 When sheet sections are being removed, their movements shall be controlled by cables or other effective means.

7. OTHER MEASURES WHILE WORKING WITH BORED OR CASSION PILING RIG

7.1 All holes which are left unattended shall be adequately and securely covered or shall have an effective barrier placed as close to the edge as is practicable.

7.2 Before any person enters a hole, the ground surface next to the hole shall be cleaned and all loose soil, materials, loose tools, ropes, etc, removed.

7.3 A person shall not remain in a hole for more than one hour at a time and this time shall be suitably reduced depending on circumstances.

7.4 Persons entering holes shall be lowered or raised in suitable skips or cages using properly constructed cranes and winches, shear legs or other devices suitable for the purpose.

7.5 In water bearing and unstable overburdens or where the sides of the hole are likely to collapse, lining tubes shall be used and those shall be penetrated wherever possible sufficiently into any impermeable stratum or rock to secure seal against ingress of ground water into the unlined hole below.

7.6 When working at night, flood lighting shall be provided for the working area. Hand lamps used for illuminating the bottom of the hole shall be of flameproof construction of not more than 24 volt rating, when men are working in the hole.

7.7 Detector lamp capable of indicating the presence of dangerous quantities of flammable gases and vapours or a serious oxygen deficiency or an excess of carbon-di-oxide shall be a part of the working gear, where poisonous gases may be present in the subsoil.

7.8 Before first lowering men into a borehole suitable steps shall be taken to investigate the likely presence of poisonous gas in the subsoil of the site.

8. ADDITIONAL MEASURES FOR WELL FOUNDATION

8.1 Well sinking work shall be under the charge of engineers or supervisors who have adequate experience in the execution of such jobs and at least one such engineer/supervisor shall be present at site whenever work is in progress.

8.2 Detailed information about the subsoil up to adequate depth below the proposed bottom of well foundations shall be collected so that the wells, including their steinings and cutting edges are designed suiting the conditions at site. This information will also assist in following safe well sinking

procedures and in taking precautionary measures in time against appearance of sudden dangers, heavy sand blow and consequent subsidence of peripherial area.

8.3 Prior geological study of terrain is recommended, particularly for rocky area and bed with boulder studed soil to enable determination of slope of rock, presence of fissures, etc, if any. Based on the information collected precautionary measures against sudden tilt and shift in well shall be taken for the safety of workmen.

8.3.1 If the study reveals presence of methane gas, approved type of methanometer shall be used to detect the presence of such gas.

8.3.2 In case methane or any other hazardous gas is detected it shall be immediately reported to the employer and further work in regard to sinking of well shall be stopped.

8.3.3 For further progressing of work at such sites all precautions necessary for working in gaseous mines shall be satisfied all the time in consultation with an expert competent to work in such mines.

8.4 Whenever well sinking is to be carried out in compressed air, safety requirements laid down in IS : 4138-1967* shall be followed.

8.5 Whenever blasting is resorted to, it shall be done under water through electric detonators by remote control arrangements and all the detonators shall be connected in series to prevent the possibility of any misfire.

8.6 Plant and equipment placed around a well for sinking shall be placed sufficiently far from the well to avoid chances of accident due to subsidence of ground on account of heavy sand blow or other causes.

8.7 If a blow is expected when the diver is working, suitable provisions shall be kept ready for him to come up quickly in the event of a blow. It is suggested that an open grab is lowered to the bottom of excavations and the winches/crane engine kept running and ready for hoisting at any time.

8.8 An air receiver with safety valve shall be attached to the compressor used for diving work. The air receiver shall be able to supply air for at least half an hour working.

8.9 The signalman working with a diver shall be his own team mate as far as possible, and in any case there shall be complete understanding between the two about the signals code to be used.

8.10 In deep water say over 30 m divers shall not work for more than half an hour at a time.

8.11 The divers shall give frequent signals about their safety.

*Safety code for working in compressed air.

8.12 All diving equipment shall be frequently checked.

8.13 When a well is loaded with heavy kentledge and a diver has to go down for inspection it shall be only for a short duration say 10 to 15 minutes.

8.14 Divers carrying out excavation work using jack hammers, pickaxes, etc, shall not go under the cutting edge of the well curb. When a stage is reached that sudden downward movement of the well may be expected, the divers shall not stay under the steining thickness but will be provided with long enough tools for doing any work at this stage.

9. PROTECTION TO NEIGHBOURING STRUCTURES AND UNDERGROUND SERVICES

9.1 In driven piles vibration is set up which may cause damage to adjoining structures or service lines depending on the nature of soil condition and the construction standard of such structures and service lines. Possible extent of all such damages shall be ascertained in advance and operation and mode of driving shall be planned with appropriate measures to ensure safety.

9.2 Wherever in the vicinity of a site where bored or driven piling works are to be carried out there are old structures which are likely to be damaged, tell-tales shall be fixed on such structures to watch their behaviour and timely precautions taken against any undesirable effect.

9.3 In case of bored or cassion piles, measures shall be taken to ensure that there is no appreciable movement of soil mass into the borehole which may cause subsidence to any existing foundation in the close proximity. In wet holes where such possibilities are likely to be there the same shall be minimized by approved technique and the operation should be planned.

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